PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Form PCT/IPEA/416
TS 1481 PCT		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/EP2004/050502	13.04.2004	15.04.2003

International Patent Classification (IPC) or national classification and IPC

C01B3/38, B01J8/06, B01J8/00, B01J8/04

Applicant

SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V.

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 6 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 2 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this repo and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplementa Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

Date of submission of the demand	Date of completion of this report
21.01.2005	20.06.2005

Name and mailing address of the international preliminary examining authority:

European Patent Office - P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk - Pays Bas
Tel. +31 70 340 - 2040 Tx: 31 651 epo nl
Fax: +31 70 340 - 3016

Authorized Officer

Van der Poel, W

Telephone No. +31 70 340-3760

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/EP2004/050502

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it wa filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets whic have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages	
1-11	as originally filed
Claims, Numbers	
1-6	received on 15.02.2005 with letter of 15.02.2005
Drawings, Sheets	
1/1	as originally filed

   ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☒ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☒ the claims, Nos. 7, 8
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industri applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-6
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-6
Industrial applicability (IA)	Yes:	Claims	1-6
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item I

Basis of the report

1. The present claims fulfil the requirements of Article 34(2)(b) PCT. New claim 1 is mostly based on claims 3 , 4 and 8 as indicated by the applicant. However, the amendments in lines 15-19 of claim 1 are not based on these passages. A basis for these amendments can be found in figure 1 and page 10, however.

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1: GB-A-1093943 (ICI)
D2: US-A-4650651 (Union Carbide)

1. The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 1 does not involve an inventive step in the sense of Article 33(3) PCT.

1.1. Document D1, which is considered to be the closest prior art, discloses a process for the preparation of synthesis gas in which a fuel (24) is partially oxidised in a vertically oriented reactor. In a separate reactor, fuel (12) is steam reformed in a convective steam reformer. The product of the steam reformer is fed in the partial oxidation reactor, where it is mixed with the product of the partial oxidation. From the figure it is apparent that the mixing takes place in the lower part of the burner. This mixture is then passed over a catalyst bed (28) which is present in the partial oxidation reactor. The product of this catalyst bed is fed through the shell of the convective steam reformer to provide the necessary heat for the endothermic reaction (see page 3, lines 10-50).

In his reply to the written opinion, the applicant has argued that document D1 is not relevant, because the present application concerns the combined partial oxidation

and convective steam reforming, wherein the temperature in the partial oxidation is between 1100 and 1500°C. However, D1 discloses exactly the same combination of process steps. Since similar fuels are oxidised, the resulting temperatures after oxidation must also lie within the above-mentioned range.

Also the temperatures mentioned in present claim 1 are not mentioned in D1. It would appear that also these temperatures are an inevitable result of performing the D1 process, especially in view of the broad ranges of temperatures presently claimed.

The only difference between claim 1 and document D1, therefore, lies in the fact that in claim 1 the reforming catalyst is positioned just below the position at which the steam reformer product is fed to the reactor, whereas in D1 there seems to be some space between the injection and catalyst.

It is noted in this respect that the term "just below" is not very clear (Article 6 PCT), but that it is slightly different from the arrangement of D1.

No technical effect has been shown from this place of introduction of the primary reformed gas. The objective problem should therefore be regarded as the provision of an alternative process. The person skilled in the art would certainly regard the arrangement as presently claimed as an obvious alternative to the arrangement of D1.

The subject-matter of claim 1 does not involve an inventive step.

1.2. A similar objection can also be made starting from document D2. This document discloses the same process in which all steps take place in one reactor. Claim 1 is obvious with respect to D2 for the same reasons as mentioned above for document D1.

2. The subject-matter of claims 2-6 also does not involve an inventive step.

2.1. Document D1 is considered to be the closest prior art for claim 2. This document uses in its example a steam to carbon ratio of 2.64. However, this document dates

from 1967 and since then many catalysts have become available, which allow to work at low steam to carbon ratios (see for example document D3 (see claims).

The person skilled in the art will, therefore, choose a catalyst which allows him to work at low steam to carbon ratio (energy efficient). The subject-matter of claim 2 does not involve an inventive step.

2.2. Document D1 shows the feeding of the steam reforming product to the lower end of the partial oxidation reactor. The subject-matter of claim 3 does not involve an inventive step.

2.3. The choice of optimal temperatures and conversions as defined in claims 4-6 can be determined by routine experiments and do not involve an inventive step.

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NEW CLAIMS

1. Process for the preparation of hydrogen and carbon monoxide containing gas from a carbonaceous feedstock by performing the following steps:
(a) partial oxidation of a carbonaceous feedstock in an vertically oriented tubular partial oxidation reactor vessel comprising a burner at its upper end thereby obtaining a first gaseous product of hydrogen and carbon monoxide having a temperature between 1100 and 1500 °C,
(b) catalytic steam reforming a carbonaceous feedstock in the presence of steam in a Convective Steam Reformer Zone thereby obtaining a steam reformer product,
(c) reducing the temperature of the first gaseous product of step (a) by between 300 and 750 °C by mixing this product with the steam reformer product of step (b)
(d) contacting the mixture obtained in step (c) with a bed of reforming catalyst positioned in the lower end of the partial oxidation reactor vessel just below the position at which the steam reformer product is fed to said reactor, and
(e) providing the required heat for the convective steam reforming reaction zone in step (b) by convective heat exchange between the mixture obtained in step (d) having a temperature between 950 and 1100 °C and the steam reformer reactor zone thereby obtaining a hydrogen and carbon monoxide containing gas having a reduced temperature.

2. Process according to claim 1, wherein the steam to carbon molar ratio of the feed to step (b) is between 0.5 and 0.9.

3. Process according to any one of claims 1-2, wherein step (c) is performed by feeding the steam reformer product to the lower end of the partial oxidation reactor vessel.

4. Process according to any one of claims 1-3, wherein the content of methane in the steam reformer product is between 1 and 10 mol% relative to the carbon present as hydrocarbon in the carbonaceous feed to step (b).

5. Process according to any one of claims 1-4, wherein the methane conversion in step (d) is between 10 and 50 wt%.

6. Process according to any one of claims 1-5, wherein the temperature of the mixture obtained in step (d) is between 980 and 1050 °C.